Landscape Assessment (LA)
Sampling and Analysis Methods

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FIELD DOCUMENTATION

Strata Definitions

With the CBI, fire effects are assessed somewhat independently within strata because vertical levels in a community have different biophysical components, and multiple levels impart structural complexities that profoundly influence fire behavior. Structure affects how wind shapes fire and the nature of available fuels. Though strata are spatially contiguous, each level may have unique combustible properties, and effects may differ strongly between them.

At times in the field, one may find vague or discontinuous boundaries between strata, where distinctions are not always clear-cut. In such cases, try to reach consensus on what is included or excluded from each stratum, and be consistent from plot to plot. If distinctions between some strata cannot be resolved, it may help to simplify the overall structure; try combining strata, or drop one out. Even if only one factor in a stratum appears to be applicable, continue to score that stratum. The main objective is to make reasonable interpretations on 1 to 5 factors within each stratum, and then combine those to derive composite ratings, which summarize severity over the overstory, understory and the total plot. The goal is not so a much high degree of precision in rating a specific factor, as it is a consistent summary rating of severity that aggregates a variety of burn-effects over multiple levels of the plot.

The strata listed below are commonly identified in a complex forest community, segregated principally by the vertical space they occupy. Their arrangement and component parts determine to some extent the character and connectivity of fuel, variation in flammability, and timing of seasonal drying. When evaluating burn severity with the CBI, fuel and fire behavior relationships are emphasized while strata species composition is less important. Consider primarily where individual plants or other materials fit within pre-fire community structure, since species may exhibit multiple life forms and occupy several strata.

Strata hierarchical structure

A. Total Plot (Overall)
B. Understory
1) Substrates
2) Herbs, Low shrubs and Trees less than 1 meter (3 ft)
3) Tall Shrubs and Trees 1 to 5 meters (3 to 16 ft)
C. Overstory
4) Intermediate Trees (pole-sized trees, subcanopy)
5) Big Trees (dominant/co-dominant trees, upper canopy)

Substrates - Inert surface materials of rock, soil, duff, litter, and downed woody fuels. We include just the surface characteristics of soil, even though soil in general could be broken into sub-strata on its own. This is an artifact of remote sensing objectives with emphasis on understanding changes to surface reflectance. Exposed soil is considered soil or rock surface that is visible from eye level and not covered by litter, duff or low herbaceous cover less than about 30 cm (12 in) high. Such surfaces that are likewise visible, but under taller shrubs and trees are considered exposed soil.

Herbs, Low Shrubs and Trees less than 1 meter (3 ft) - All grasses and forbs, plus shrubs and small trees less than 1 meter (3 ft) tall. Herbs are plants that die back to ground level each year. Shrubs retain persistent aboveground woody stems, from which subsequent years growth develops. Small trees, including tree seedlings, are like shrubs, but typically have only one central stalk, and eventually grow to heights far exceeding this one-meter size class.

Tall Shrubs and Trees 1 to 5 meters (3 to 16 ft) - Shrubs and small trees generally greater than 1 meter (3 ft) and less than 5 meters (15 ft) tall. If trees or shrubs are between 5 meters (15 ft) and 8 meters (25 ft) tall, decide which stratum the life form fits best. They could be scored with intermediate trees, but only if they are distinctly tree-like and have characteristics of other intermediate trees. When there is question between this stratum and intermediate trees, look at the community at large, beyond the plot if necessary, and consider whether there really are two strata with one being distinctly taller and over the other. If not, then in most situations you would elect to score only one stratum. Also, consider the life form, and whether there is dense branching that extends nearly to the ground, such that fire behavior may be influenced by that in particular ways. This occurs on both counts for many pinyon/juniper communities, for example, where they would be scored for tall shrubs and trees 1 to 5 meters (3 to 16ft), but not for intermediate trees.

Intermediate Trees (pole-sized trees, subcanopy) - Trees occupying space between the tall-shrub/sapling layer and the uppermost canopy; generally 10 to 25 cm (4 to 10 in.) diameter, and 8 to 20 meters (25 to 65 ft) tall. If trees of this size are the uppermost canopy, then consider them as intermediate trees while not counting a big tree stratum. This stratum may itself be of stratified heights, with crown tops extending into the upper canopy. Still consider, however, that they are intermediate trees, if they receive little direct sunlight from above. Actual size of the intermediate trees is relative to height of upper canopy and may vary from community to community.

Big Trees (dominant and co-dominant trees, upper canopy) – Dominant and co-dominant trees that are larger than intermediate trees. They occupy the uppermost canopy, and usually receive direct sunlight from above. These tree crowns form the general or average level of the upper canopy, while some individuals may extend above that.

Understory - The region comprised of substrates, herbs/low shrubs/trees < 1 meter, and tall shrubs/trees 1-5 meters.

Overstory - The region above the understory, consisting of intermediate and big trees.

Total Plot, or Overall - All strata of the plot combined.

Note: Composite scores reflect only those strata that existed before fire. As a rule, strata that are not applicable on a plot cannot be rated and are not considered in the composite ratings. If a plot contains no trees, for example, then only the first three strata would be rated. In that case, we would consider the assemblage an "understory" (even though an implied "overstory" is missing), and use only the combined understory factor scores for the overall rating. The hierarchy intends to accommodate structurally complex communities, while not requiring the presence of all strata.

Initial Summary of Area Burned

Percent Plot Area Burned: Before examining the individual severity factors within strata, record the percent surface area showing *any* impact from fire for the 30 meter (100 ft) diameter plot, and for the nested 20 meter plot (66 ft), if that is used for the understory. This always reflects the area of burned substrates and low-growing plants. If there is a rare case with area of burned overstory but unburned understory, count that overstory burn as well, as if viewed from the air. Do not subtract, however, unburned overstory from the burned area of the understory. The percentages are entered early on to set upper limits for rating factors that reference burn effects by proportional area of the plot. These preliminary entries are important, so please make every effort to record them. Note that the 30-meter (100 ft) plot covers about two and a quarter times the area of the 20-meter (66 ft) plot. Rectangular dimensions are provided at the bottom of the CBI form to help equate plot percentages with ground area as a means of visualizing these quantities.

Pre-fire Conditions: The CBI form contains a few fields in each stratum for estimating pre-fire variables such as cover, depth and density. Complete these as possible, trying to most-reasonably represent those specific conditions, as they would have appeared before fire. Make sure pre-fire non-burnable areas within the plot (e.g. soil and rock) are estimated, so they can be used to calibrate scores later on. Reference within-plot or nearby unburned areas, or evidence such as char heights, amount of charcoal, or number of standing snags. Report cover by percent of plot area, depth in inches, and density of trees as an estimated number of individuals on a plot. The intent is to get general approximate information about pre-fire conditions. The values will be useful later to possibly weight strata, or to categorize plots and group them in analysis across the potential range of pre-fire starting points. Remember to take time to compare burned areas with unburned areas to get as good an understanding of pre-fire conditions as possible. If any pre-fire information is not feasible to estimate, then enter "not applicable" (N/A) or "uncertain" (UC) on the Field Form. Do not leave the fields blank.

Enhanced Growth Factors: Fields for Enhanced Growth are provided on the CBI form under Herb/Low Shrub/Tree and Tall Shrub/Tree strata. They are used to record whether or not fire has actually enhanced the productivity of herbs, shrubs or trees above-and-beyond the level that was on the plot before fire. Productivity can be regarded as amount of green living biomass, in terms of cover, volume and density. If plots show about the same or less estimated productivity than before fire, then these variables should be entered as not applicable (N/A). If there is cause to believe that a plot shows enhanced growth, then enter the percent productivity that is judged to be augmented by fire, with 100% being the same post-fire productivity as pre-fire. An entry of 200 percent, for example, would represent double the estimated productivity that was there before fire, and 150 percent would constitute one and a half times more green vegetation than pre-fire. Reference similar but unburned areas in or near the plot to gauge the possible effect of fire on enhancing growth.

Rating Factor Definitions

Calculated CBI scores for understory, overstory, and total-plot depend mainly on a variety of factors being independently examined and comparably scored. Factors are grouped by strata so field samplers can focus on a particular group of potentially related effects. Strata can then be evaluated in sequence to reflect on whether or not each unit is being scored appropriately. A goal is transferability across regions, and as generically as possible, factors are designed as a framework of components that respond to fire. In addition to the CBI scores, strata-level information can be retained and used in other applications.

It may be tempting to adjust rating factors and criteria to a particular area, but that is not encouraged without carefully considering the entire framework and strategy of the approach. Factors and criteria are designed to balance each other, such that ratings do not double-count basically the same effect, or exaggerate one effect over other mitigating effects. In the end, modifications may only add unnecessary detail and diminish the applicability to other areas.

Within strata, the factors that are rated are generally common and relatively easy to observe after fire. Those selected are also ones that may influence surface reflectance directly, and be likely elements of a collective signal detected by satellite. As such, rating factors may not include all the effects that may be of interest to fire ecologists and managers (e.g. sub-surface soil properties). Those other conditions of interest, such as exotic species, can be documented in the Community Notes section of the CBI form.

At present, severity factors are considered equal when averaged into composite levels. In reality, that may not be the case. If one could judge the overall ecological significance of a factor relative to another, factors could be weighted before averaging to improve the measure. For example, it is likely that removal of the tree canopy has longer lasting consequences than removal of litter or fuel from the substrate. However, those relationships are not easily quantified, so at present, effects are simply considered equal contributors when averaged for CBI severity.

Most Rating Factors are interpreted relative to conditions that existed before fire, and not in absolute quantities. This responds to the definition of severity as a magnitude of ecological change, such that the amount of change depends on the state of the community before fire. It is

particularly true for all understory ratings, and why the pre-fire estimates on the CBI form are so important. In addition, all factors are considered in terms of the area of the whole plot. Thus, all areas of a plot are averaged together to derive each rating, adding in unburned spots and mottled burn patterns of varying severity.

Like strata, factors that are not applicable or cannot be resolved in a plot are not rated; they are omitted from that plot's composite ratings. Moreover, if there is much uncertainty about how a specific factor should be rated, or whether it is even relevant to the plot, then that factor should be left unranked. Only the number of rated factors is used to compute averages. If a factor is not rated, enter not applicable (N/A) or uncertain (UC) on the CBI Field Form. Do not just leave the field blank. As stated previously, such factors are not part of the CBI average, but one wants to know whether these factors were actually assessed and it was decided not to rate them, or just accidentally overlooked and skipped.
Zeros, on the other hand, are valid entries and do get averaged into composite scores. Zeros should be used when a rating factor is applicable and exhibits an unburned condition. A Zero represents no detected change in an observable factor.

Field personnel need to use judgment as to whether or not a factor to be rated has some minimal level of significance as a reference to burn severity on a plot. That pertains to whether or not the factor had enough presence on the plot before fire so as to show representative effects after the fire, or did it contribute some influence on fire behavior. If for example, there is only one large fuel item, and it covered an insignificant portion of a plot, then it may not be worth rating. That one piece of wood is not likely to provide much information about severity realized across the plot. Other examples are provided under the specific rating factors, below.

If an area has burned more than once in recent years, try to find places where you can compare sites that burned only once in the most recent fire and once in the older fire(s). Look for clues that might identify the age of the evidence, so that when you are on a plot that burned twice, one can separate out the most current fire effects from older ones. The sheen on charcoal dulls with age, for example, and annual nodes on burned shrubs can indicate the years of regrowth since fire. Older burn indicators are not be used in the evaluation of current fire effects. If reliable indicators to distinguish multiple burns on a site cannot be found, it may be best to reject the plot, or skip those rating factors that are not definitive.

If a site has been rehabbed after fire, added mulch, straw or woody barriers should not be counted, rather substrate estimates should be made as if that new material were not present. Any planted and growing vegetation, however, can be tallied where appropriate, such as change to species composition/relative abundance. But, rehabbed vegetation should not be included as new colonizers, since its response was through cultural activities rather than fire. The extent of rehabilitation should be recorded on the Field Form under Community Notes/Comments.

The primary objective for rating factors is to reach a reasonable cumulative score for each stratum based on field personnel's expert knowledge of fire effects. The CBI simply helps to focus that knowledge in discrete directions and provides a standard structure to quantify severity. It is the combination of many ratings, not the precision of any one specific factor score that gives strength to the CBI.

Substrate rating factors

These factors are rated in relation to the substrate components that existed before fire. Recent post-fire additions to substrates, *excluding soil*, are generally not considered in these ratings. That means you should not count litter, duff or woody fuels that accumulated after fire. Rather, you should identify and mentally remove that newly fallen material to rate what is underneath. Interpretations should be based on those substrates that were in place at the time of fire.

Make sure to include substrate areas that did not burn as unchanged (e.g. unburned patches and pre-fire areas of exposed mineral soil or rock) when estimating average plot-wide changes to duff, litter and soil. Pre-fire non-burnable area within the plot (e.g. soil and rock) must be estimated and entered in the pre-fire field on the form, so it can be referred to later on. It is potentially important as a weighting factor for calibration of the dNBR. Exposed soil is considered soil or rock surface that is visible from eye level and not covered by litter, duff or low herbaceous cover less than about 30 cm (12 in) high. Such surfaces that are likewise visible, but under taller shrubs and trees, count as exposed soil.

If there are areas of a plot that cannot possibly burn, such as large pre-fire exposed rock, then those areas should be treated as unburned. Some caution needs to be exercised, however, because burnable materials, such as litter or vegetation, can cover pre-fire rock. In those cases, the rock surfaces could have "burned" and they could be treated as burned area within the plot. Charring of rock surfaces and pockets of charcoal can provide clues to that effect. Cobbles and stones less than a 0.5 meter (1.5 ft) or so in diameter may or may not fall in this category, depending on pre-fire overstory characteristics and to what degree they were covered by litter, duff, or vegetation before fire. Sites generally should be avoided if they contained more than about 50 percent exposed rock before fire. Such plots would not reveal much about fire effects, and would appear as essentially unburned. There may be occasion, however, to include a few such areas to confirm remote sensing results.

Litter and Light Fuels - Relative amount consumed of small organic materials lying on the surface of the ground, including leaves, needles, and woody material less than 3 inches in diameter (7.6 cm). All litter is counted even though some may occur under living vegetation. Incorporate non-living attached basal material, such as dead grass or rosette leaves. In deciduous forest, late season burns are often followed by significant leaf fall, so rate the litter as if the freshly fallen leaves were not present. The same applies to freshly fallen conifer needles. If no light fuels are present, the maximum score, based solely on litter is a 2.0. Scores above 2.0 need to include some significant portion of light woody fuel consumption. This rating relates to percent change in the litter and light fuels cover estimated at the time of fire, not in relation to total plot area. For example, if litter and light fuels covered 70 percent of the plot and the fire consumed all litter and light fuels, there would be 100 percent change in cover, even though the change only amounted to 70 percent of the plot area. The rating in that case would be a 3.0. Pre-fire estimates of litter and light fuels cover can be used to weight this factor to determine percent of plot-wide change. Litter should probably be assessed as "not applicable" if cover was less than 20-25 percent of a plot before fire.

Duff condition - Relative amount consumed and charring of organic materials that lie beneath the litter and above the soil. Duff is organic material that has undergone considerable

decomposition prior to the fire. All duff is counted even though some may occur under living vegetation. Do not consider fine root mass left after duff is consumed to be part of the duff rating. If there was a deep pre-fire duff layer, then one could use the absence of fine root mass as an indicator of intense fire, which could affect soil structure or chemistry, and influence the soil severity rating, below. Like litter, this rating relates to percent change in post-fire duff cover compared to pre-fire cover; not in relation to total plot area. For example, if duff covered 70 percent of the pre-fire plot and the fire consumed all duff, the change in cover would be 100 percent resulting in a CBI score of 3.0. Duff should probably be rated as "not applicable" if it is less than 0.25 inch (0.6 cm) deep and covers less than 20-25 percent of a plot before fire. At such low occurrence, duff can be treated as part of the Litter and Light Fuels rating factor.

Medium Fuels 3 to 8 inch – This factor gauges primarily consumption of downed woody fuels between about 3 inches (7.6 cm) to 8 inches (20.3 cm) in diameter. Base consumption on the percent of volume or weight lost in relation to estimated plot-wide pre-fire fuel load for this class. Consumption includes conversion of woody material to inorganic carbon (charcoal), as well as the complete loss woody fuel. Generally, this factor should not be used when such fuels cover less than about 5 percent of the 20-meter (65 ft) diameter understory plot (an area about 3 x 5 meters or 10 x 25 ft) or when they are distributed in only one localized area of the plot. If there is not enough fuel to separately score medium and large fuels, but the fuel could be scored if size classes were combined, go ahead and score one of the two factors on the form, using the one which seems most common, and make a note to that effect in comments field. Stumps that existed before fire can be included in this fuel size category or ignored all together, as deemed appropriate.

Large Fuels >8 inches - Includes consumption and charring of downed woody fuels greater than 8 inches in diameter (20.3 cm). Base consumption on the percent of volume or weight lost in relation to plot-wide pre-fire fuel load for this class. Consumption includes conversion of woody material to inorganic carbon (charcoal), as well as the complete loss woody fuel. This factor should not be used when such fuels cover less than about 5 percent of the 20-meter (65 ft) diameter understory plot or when they are distributed in only one localized area of the plot. See note above under Medium Fuels, to determine when to combine medium and large fuels. Stumps that existed before fire can be included in this fuel size category or ignored all together, as deemed appropriate.

Change in Soil Percent Cover and Color - Increase in percent cover of newly exposed mineral soil and rock, over and above estimated pre-fire levels plot-wide. Exposed soil is considered soil or rock surface that is visible from eye level and not covered by litter, duff or low herbaceous cover less than about 30 cm (12 in) high. Such surfaces that are likewise visible, but under taller shrubs and trees, count as exposed soil. Exposed rock that "burned" due to pre-fire covering of litter, duff or vegetation should be treated as newly exposed soil. The key interpretation is change in the percent cover. Ash and charcoal from consumed woody fuel, as well as newly exposed fine root mass within consumed duff layers, are overlooked when estimating exposed soil (i.e. all the new soil below those components is considered).

Change in Soil Color – Change in soil color may also provide clues to severity. Base ratings on the proportion of exposed soil changing from native color to a general lightening with loss of organics at moderate to moderate-high severity, and up to 10 percent soil cover changing to a

reddish color from oxidation at high severity. The amount of reddish soil varies by soil type, thus adaptation to particular ecosystems is warranted.

These five examples are provided to help you sample the substrates:

If a plot had 20 percent exposed pre-fire rock (meaning no litter, duff, down woody fuels, or smaller herbs or shrubs covering the rock before fire), then only up to 80 percent of the plot could have burned. If fire consumed all litter, light fuels and duff that covered the remaining 80 percent of the plot, then the estimated litter and duff consumption on the plot would be 100 percent resulting in ratings of 3.0 for both litter/light fuels and duff, and an entry of 80% for the percent of plot burned.

If 70 percent of a plot appears to be exposed rock or soil that existed before fire, you should not sample that plot in most cases.

A plot had essentially continuous cover of litter, light fuels and duff before fire, and 80% of the plot burned (20% was unburned). If fire consumed all litter and light fuels, and 50% of the duff within the area that burned, then plot-wide litter and light fuel consumption would be 80%, and plot-wide duff consumption would be 40% (half of the 80% of the plot that burned).

If fire consumed all litter and duff, and a fine layer of ash covers the soil, ignore the ash and treat the area as newly exposed mineral soil when rating that factor. You should scrape through the ash in places to examine the soil.

If a burn occurs in deciduous forest and it consumes all litter and duff before the current leaves have fallen, you should consider litter and duff consumption and newly exposed mineral soil to be 100 percent. Newly fallen leaves are not included in any of the substrate ratings.

Herbs, low shrubs and trees less than 1 meter rating factors

As with substrates, field personnel must determine initially whether herb, low shrub and/or small tree rating factors are sufficiently represented on a plot to justify scoring them. The stratum should have been sufficiently present to indicate severity after fire. In general, suspected pre-fire coverage of less than about 5 percent of the plot, or very limited distribution throughout, might not be enough and may lead you not to count at least some of the factors. Such cases may occur under dense conifer canopies where the pre-fire understory consisted solely of needle-cast litter and duff, or in other cases, where vegetation was very sparse and exposed soil was relatively high. At times, however, even small cover of herbs and low shrubs can be diagnostic, so take time before concluding not to score them.

Percent Foliage Altered – Percent of pre-fire woody-species cover that was impacted by fire as estimated by change in cover from green to brown or black. This only concerns the pre-fire low shrubs and small trees, not grasses and herbs. It includes girdle, scorch and torch of needles, leaves and stems. Resprouting from the base of shrubs or trees is not considered in this estimate of altered foliage, only the pre-fire foliage is. In other words, the entire blackened crown of a low shrub counts as pre-fire foliage altered, even though it may be resprouting. The amount of

resprouting does not lessen the percent of pre-fire foliage altered. At high levels of severity, consumption of outer fine branching on low shrubs and small trees has occurred.

Frequency Percent Living – Percent of pre-fire vegetation that is still alive after fire. This is a measure of survivorship based on numbers of individuals and not necessarily on change in cover. Include unburned as well as burned, resprouting perennial herbs, low shrubs, and small trees plot-wide. Resprouting plants are ones that burned, but survive from living roots and stems. Include all green vegetation, as well as burned plants that have not had enough time to resprout but remain viable. Burned plants may need to be examined for viable cambium or succulent buds near growth points. Dead stems will be brittle when bent, still living ones supple. Do not include new colonizers or other plants newly germinating from seed. Make sure to take in the whole plot in the average score including unburned areas.

New Colonizers – Potential dominance within 2 to 3 years post fire of plants newly generating from seed (native or exotic) averaged over the plot. The basis for this rating is the proliferation of such species due to fire, that is, above and beyond what might be expected had fire not occurred. Relative frequency of colonizers compared to established plants may be more recognizable at first, with relative cover increasing over time. This includes herbs like fireweed, thistle and pokeweed as well as new tree or shrub seedlings. It also includes increased dominance of nonvascular plants that proliferate after fire in some areas, such as fungi, bryophytes, lycopodium, and small fine-leaved moss. Such plants should be rated with an understanding of how such species respond to fire. You should consult local botanists if not familiar with these species in a particular area to be confident in the appropriateness of rating these plant populations.

New colonizers also include aspen suckers that generate from former trees, as well as similar tree-to-shrub responses from other species. Suckers are defined as stem-growth originating from underground roots or rhizomes, as opposed to from branches or central trunks. All suckers are counted here even though some may exceed 1 meter (3 ft) in height, because: 1) they represent a change in life form from top-killed trees; 2) they often disperse widely from spreading root masses; and 3) they are functionally equivalent to colonizers occupying new ground recently prepared by fire. Such effects are not counted in the tall shrub stratum, because: 1) other colonizers in that stratum do not seem to exist, so the factor was omitted from that stratum; 2) it seems most efficient and representative to rate suckers within only one stratum and not two; 3) tree seedlings, which suckers functionally resemble, are counted only within the herb and low shrub stratum; and 4) no matter where they are counted, they will contribute the same to the understory CBI score.

For trees, include newly seed-established conifers, such as lodgepole pine, ponderosa pine, table mountain pine, long leaf pine, slash pine or other coniferous or deciduous trees that colonize after fire. Tree seedling response after fire can be site specific, but in general, certain tree species are adapted to fire, taking advantage of fire-prepared soil and openings.

Species Composition and/or Relative Abundance - Change in species composition, and/or relative abundance of species anticipated within 2 to 3 years post fire. This is a community-based assessment that gauges the ecological resemblance of the post-fire community compared to the community that existed before fire. It represents alterations in dominance among species

(biomass or cover), as well as potential change in the species present, such as absence of pre-fire species and/or presence of new post-fire species. Consider the distribution of abundance or dominance among the species present after fire, compared to before fire. Such factors qualitatively determine the similarity or dissimilarity of the site from before to after fire. Increases or decreases in certain species abundance and dominance, or changes in the species present after fire raise the score for this rating factor.

These four examples are provided to help you sample the Herb, Low Shrub and Trees less than 1-meter tall.

A plot had understory cover distributed throughout all sections, which seemed to consist only of perennial herbs. If 50 percent of the plot did not burn and fire appeared to have killed 90 percent of perennial herbs on the remaining 50 percent of the plot, then "frequency percent living" would be about 55 percent plot-wide (50 percent unburned plus 5 percent resprouting). Foliage altered, on the other hand, would not be rated because the site did not appear to contain low shrubs or small trees before fire.

By observing nearby unburned areas, it was reasonable to assume that a burned plot still contained most, if not all, of the 8 to 12 herb and low shrub species present before fire. It was also apparent, however, that a few small shrub species, like *Vaccinium* and *Ribes* were knocked back by the fire, while dominance of two herbs, *Calamagrostis* and *Epilobium* was enhanced. Since original community composition was largely intact, and it was mainly just two species increasing with two decreasing, change in species composition/relative abundance could fall in a range of low to moderate on the CBI form. This would depend on the magnitude of change in dominance exhibited by the species diminished and enhanced by the fire.

If "frequency percent living" is low, and there are large numbers of new colonizers, then most likely change in species composition/relative abundance would be fairly high.

Tall shrub and trees 1 to 5 meters rating factors

Percent Foliage Altered – Percent of pre-fire foliage for tall shrubs and trees 1 to 5 meters that was impacted by fire, as estimated by change in crown volume from green to brown or black. This includes girdle, scorch and torch of needles, leaves and stems. Resprouting from the base of shrubs or trees is not considered in this estimate of altered, only the pre-fire foliage is. In other words, the entire blackened top-killed crown of a tall shrub counts as pre-fire foliage altered, even though there may be a portion that is resprouting. The volume of the resprouting is ignored; it does not lessen the amount of pre-fire foliage altered. At high levels of severity, consumption of outer fine branching on shrubs and trees is evident. In fall burns and leaf-off conditions, base the score on effects to remaining boles and branches, the degree of outer-branch consumption, and whether or not fire top-killed plants.

Frequency Percent Living – Percent of pre-fire tall shrubs and saplings that are still alive after fire. This is a measure of survivorship based on numbers of individuals, not on change in cover or crown volume. Include unburned area as well as burned but resprouting tall shrubs and trees 1-5 meters tall plot-wide. Resprouting plants are ones that burned and survive from living roots

and stems. Include all green plants, plus burned plants that have not had enough time to resprout but remain viable. Burned plants may need to be examined for viable cambium or succulent buds near growth points. Dead stems will be brittle when bent; living ones will be supple. Do not include new colonizers, such as aspen suckers or other plants newly germinating from seed. Account for potential mortality that could occur up to two years post fire (e.g. conifer saplings that are 70% brown will likely die in two years), and make sure to average plot-wide, including unburned areas.

Percent Change in Cover - Overall *decrease* in cover of shrubs and trees between 1 and 5 m tall, relative to the area occupied by those plants before fire. Count resprouting from plants that burned, plus the unburned plants, as cover that mitigates against or lessens the amount of decrease in cover. Do not include new colonizers or other plants newly germinating from seeds, including suckers that represent tree-to-shrub responses. Suckers from aspen and other species are counted as new colonizers that generate from underground roots or rhizomes, as opposed to from branches or central trunks. Make sure to average plot-wide, including unburned areas. Account for potential mortality that could occur up to two years post fire (e.g. conifer saplings that are 70% brown will likely die in two years).

Here is one example of how to score the Percent Change in Cover. A plot had 20% estimated cover for tall shrub before fire. An estimated half of that cover *did not* burn, and a tenth of pre-fire cover though burned was still green from resprouting. The remainder was burned and completely killed (no evidence of resprouting potential). The overall decrease in cover then, would be estimated at 40% (100% minus 50% minus 10%), and given a factor rating of about 1.3. The pre-fire estimated cover of 20% would also be entered on the form.

Species Composition and/or Relative Abundance - Change in species composition, and/or relative abundance of species anticipated within 2 to 3 years post fire. Include pre-fire tall shrubs and trees 1-5 meters tall, as well as big and intermediate trees resprouting from the base. Basal sprouting from larger trees is included here because: 1) the growth form changes from tree-like to shrubby and then to multi-stemmed saplings; 2) basal tree resprout does not seem to represent a fire effect on pre-fire large shrubs, as would be counted under large-shrub resprouting; 3) growth tends to be restricted around root crowns and not spreading widely from the burned trunk, as in suckering; and 4) this needs to be counted somewhere, but only once, and these individuals will contribute to the large shrub/sapling community for some extended period of years. This is a community-wide assessment that gauges the ecological resemblance of the post-fire community compared to the community that existed before fire. It represents alterations in dominance among species (biomass or cover), as well as potential change in the species present, such as absence of pre-fire species and/or presence of new post-fire species. Consider the distribution of abundance or dominance among the species present after fire, compared to before fire. Such factors qualitatively determine the similarity or dissimilarity of the burned site to the pre-fire site. Increases or decreases in certain species abundance and dominance, or changes in the species present after fire raise the score for this rating factor.

Intermediate and big tree rating factors (combined)

Generally for northern and western conifer forests in the U.S. the sum of the first three factors - Percent Unaltered, Percent Black and Percent Brown - will be 100 percent. That may not be the case, however, in some deciduous forests or southeastern pine forests, where crowns may have been blackened or torched, but not killed and subsequently resprout. In such cases, continue to score the unaltered, black and brown factors as they appear on the site, even though they may add up to more than 100%. The balance of the three factors should still maintain appropriate overall ratings for severity in the overstory.

Often insects or disease can affect fire-stressed trees very soon after burning. If these sorts of effects are suspected and observed within a year or two of the fire, our tendency is to include them as fire-caused change. They would be relevant to the percent brown and canopy mortality rating factors, below, as well as to supplemental factors, like percent girdled and tree mortality.

Percent Unaltered (Green) – Percent of pre-fire crown foliage volume (living or dead) unaltered by fire, relative to estimated pre-fire crown volume of the plot. Include resprouting from burned crowns, but not from tree bases, as unaltered/green.

Percent Black (torch) – Percent black is pre-fire crown foliage (living or dead) that actually caught fire, stems and leaves included, relative to estimated pre-fire crown volume plot-wide. May or may not be viable crown foliage after fire. At high severity, consumption of fine branching is evident. Do not consider resprouting from black branches as lessening the percent black. In many cases, deciduous trees will not torch especially when leaves are off; yet high flame lengths from the ground may blacken virtually the entire tree. Due to the aerial intensity of such fire and its similarity to crown fire, this type of burn is also included in the percent black rating.

Percent Brown (scorch) – Percent of tree canopy affected by scorch or killed by girdling, in relation to the estimated pre-fire crown volume over the whole plot. This is foliage killed by proximal heating without direct flame contact (i.e. brown foliage that did not actually catch fire). It includes scorching effects at the time of fire, as well as delayed mortality, often from heat impacts around tree boles and roots. Suspected insect and disease effects also may be included, if that is manifested in the crowns relatively soon after fire (e.g. within about 2 years). This avoids a need to separate burn impacts from similar-appearing and related foliage conditions caused by fire-induced pathogens. Include crowns obviously impacted by these effects, even though brown foliage may have fallen to the ground. Include deciduous trees burned in leaf-off condition that are not resprouting from crowns. In those cases, look for dead crowns or portions of crowns that do not contain any black but may show severe charring around lower trunks or at ground level.

Percent Canopy Mortality – Of trees killed by fire or expected to die within 2 years, this should represent the proportion of crown volume now contributed by fire-killed trees (e.g. the proportion of once-living crown volume that is now dead). Consider in relation to crown volume still contributed by surviving trees. Only count trees that are completely dead, not the fire-killed portions of crowns that may still exist on living trees. One can count completely top-killed crowns on trees that show shrubby basal resprout. The factor is viewed as the proportion of a plot's total once-living canopy now lost because of recently dead trees. Suspected insect and

disease effects also may be included, if that has contributed to killing whole trees relatively soon after fire (e.g. within about 2 years). This avoids a need to separate burn impacts from similar-appearing and related foliage conditions caused by fire-induced insects or disease.

Char Height - The average height of char on tree trunks resulting from ground flames. This is the mean height on individual trees averaged over all trees in the plot. The mean height on a given tree is determined as halfway between upper char height and lower char height. Trees on slopes typically have char running up higher on the up-slope side, and wind-driven flames usually result in char running up higher on the leeward side of trees. Include unburned trees (char height = 0) and burned trees only where demarcation of ground char height is discernable. This rating does not include the black on upper boles resulting from crown fire. Trees that do not clearly show where ground flames ended and crown fire began are not included in the score. Thus, char height may not be applicable where crown fire predominates.

Three additional overstory factors are estimated but not to averaged into CBI Scores.
These are entered as plot-wide average conditions. They provide useful information to help interpret the rating factors for the overstory. Include recent post-fire insect and disease effects where appropriate.

Percent Girdled (at root or lower bole) - Percent of trees effectively killed by heat through the lower bark, affecting the cambium around the circumference of lower boles or buttress roots. Girdling may or may not actually char through the bark and into the wood. It is often indicated a year or more after fire by sheets of bark loosely attached or sloughing off the lower bole. Include trees either dead or likely to die within 1 to 2 years. Do not include trees killed by crown fire or other scorching to crown.

Percent Felled (downed) - Percent of trees, whether dead or alive, that were standing before fire but now are laying on the ground. Such trees usually result from wind throw after fire. They typically exhibit fresh up-turned root masses and different charring patterns than trees that were down when the fire occurred.

Percent Tree Mortality – Estimated percent of trees in each of the two size classes that died on the plot from the most-recent fire, or are expected to die within 1 to 2 years. The percent is based on the number of dead trees post-fire compared to the estimated number of living trees before fire. Mortality should be judged on compelling evidence that, with 90 percent certainty, the trees are dead or will die.

Community Notes and Comments

Community notes or comments about burn patterns within the plot are optional, but helpful in subsequent analysis. Attributes to consider here include: 1) height and density of the various strata; 2) dominant species present per strata; 3) general fuel characteristics; 4) general microclimate, moisture and topography; 5) evidence of insects or disease; and 6) any descriptors about the burn mosaic. Other comments may refer to the suitability of the plot, for example, when the plot straddles an edge or has signs of disturbance other than fire, like post-fire salvage logging or other rehab. Record any information that may potentially be useful to others, such as

observations of rare plants, cultural resources exposed or affected by fire, interesting wildlife (including carcasses), as well as erosion or water quality evidence.

Data Sheets

The **Composite Burn Index Field Form** (BI) is for use in the field when direct digital entry is not possible. It includes the scaled criteria for rating severity factors, which helps calibrate field interpretations among observers. The Cheat Sheet and Field Documentation, above, should also accompany field crews to standardize definitions of strata and rating factors. Once back in the office, field data can be entered using the FIREMON database software or the National Park Service FEAT database software for PD (Plot Description) and BI. Note, strata mean scores and the CBI ratings will be computed on the fly as data are entered in BI or FEAT. Check these values against those calculated in the field, and correct the data sheets if necessary. At the time plot photos are digitized and given filenames, that information is updated for a given plot using the PD database. Entry of digital plot photo filenames can also be made on the appropriate data sheet.