# THE DEVELOPMENT OF A SOUTHERN APPALACHIAN MOUNTAIN FUELS PHOTO SERIES

**T. Adam Coates, Thomas A. Waldrop, Helen H. Mohr, and Todd F. Hutchinson**

**Abstract**—The use of a fuels photo series to characterize potential combustibles and adequately anticipate and predict potential wildfire and prescribed fire behavior and effects in a given area is a practice that began nearly 50 years ago. These photo series are regional in nature and have tended to characterize the variability in Western United States fuel complexes in finer detail than Eastern United States fuel complexes. Managers and practitioners have long expressed great interest in a more site-specific, Southern Appalachian Mountain fuels photo series. In this article, we present the developmental framework for a new Southern Appalachian Mountain fuels photo series that was created in 2019 (Coates and others 2019).

## INTRODUCTION

Prescribed fire is a forest management practice used extensively throughout the Southeastern United States to accomplish a variety of landowner objectives, such as hazardous fuel reduction, slash and debris reduction for site preparation, wildlife habitat enhancement, vegetative control of less-desired species, and ecosystem restoration (Waldrop and Goodrick 2012). It is well documented that wildland fire has been part of the Appalachian region for centuries (Lafon and others 2017), but much of the scientific understanding needed to utilize fire for the accomplishment of long-term management in this region is still emerging. Many managers and scientists in the region have desired a reference tool to aid in the determination of Appalachian-specific fuel loads as a means to better predict and anticipate potential fire behavior.

Fuels photo guides for the Eastern United States have included ones specific for estimating fuel loads as a result of clearcut harvesting (Sanders and Van Lear 1988) or post-hurricane damage in southern pine forests (Wade and others 1993). Also, a photo guide was specifically created for loblolly (*Pinus taeda*) and longleaf pine (*P. palustris*) plantations in the upper Coastal Plain region (Scholl and Waldrop 1999). Other photo guides have included managed and unmanaged stands. For northern hardwood and oak-hickory (*Quercus* spp.-*Carya* spp.) forest types, Wilcox and others (1982) developed a guide for each forest type, also grouped by site, class, and harvest history. A more recent guide developed for the Mid-Atlantic States gives users pre- and post-prescribed fire data arranged by differing levels of fuel types including leaf litter, ericaceous shrubs, and logging slash (Brose 2009). No fuels photo guide has been developed specifically for long-unburned stands in the Southern Appalachians. It is our goal with the production of this guide to take the first step in that direction.

## METHODS

The new Southern Appalachian Mountain fuels photo guide was developed using photographs, site descriptions, and forest fuels inventories obtained from 705 research plots located on portions of the following Federal lands: Great Smoky Mountains National Park (Tennessee) and the Andrew Pickens (Sumter National Forest, South Carolina), Chattooga River (Chattahoochee National Forest, Georgia), and Nantahala (Nantahala National Forest, North Carolina) Ranger Districts (Waldrop and others 2007). All plots were located in areas where prescribed fire might be utilized to achieve forest management objectives.

### Field Data Collection

In the field, fuels inventories were conducted using Brown's Planar Intersect Method (Brown 1974), as modified by Stottlemyer (2004) (fig. 1). Using this technique, down and dead woody debris 0–1/4 inch, 1/4–1 inch, 1–3 inches, and >3 inches in diameter was tallied as 1-, 10-, 100-, and 1,000-hour timelag size classes, respectively, along three 50-foot transects established at a 45° angle. Timelag refers to how each individual fuel-size class responds to changes in relative humidity (Brown 1974). Using this method, 1-hour and 10-hour fuels were tallied within the first 6 feet of each

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transect, 100-hour fuels were tallied within the first 12 feet, and 1,000-hour fuels were tallied along the entire 50-foot transect. A quality rating (sound or rotten) was additionally recorded for 1,000-hour fuels.

Estimates of fuel loading in tons per acre (*W*) were derived for each fuel-size class based upon these equations (Brown 1974):

For material ≤3 inches: $W = (11.64)(n*d^2*s*a*c) / N*L$ (1)

For material >3 inches: $W = (11.64)(\Sigma d^2*s*a*c) / N*L$ (2)

where

11.64 = conversion factor of volume to tons per acre;
*n* = the number of woody fuels tallied per timelag-size class;
*d* = quadratic mean diameter of particles (inches);
*s* = specific gravity of fuels (*s* = 0.70, 0.58, 0.58, and 0.30 for 0–1/4-inch, 1–3-inch, >3-inch sound, and >3-inch rotten material, respectively) (Anderson 1978);
*a* = non-horizontal angle correction factor;
*c* = slope correction factor;
*N* = number of transects at each plot (*N* = 3); and
*L* = length (feet) of sampling plane (*L* = 6 for 1- and 10-hour fuels; *L* = 12 for 100-hour fuels; and *L* = 50 for 1,000-hour fuels).

Litter depth, duff depth, and fuel bed height (defined as the distance from the top of the litter layer to the top of any coarse woody debris crossing the transect) were measured at three locations along each 50-foot transect: 12–13 feet, 24–25 feet, and 40–41 feet (fig. 2). Thus, plot averages for each variable were based upon nine individual measurements.

Ericaceous shrub (*Rhododendron maximum* or *Kalmia latifolia*) cover was calculated by measuring the canopy dimensions of each shrub using 50-foot measuring tapes within the 0.025-acre fixed-area plot. Ground cover vegetation <1 foot tall was visually estimated in the same 0.025-acre fixed-area plots (fig. 3).

The range pole in the photographs was 6 feet tall and was placed at the 40-foot mark along the

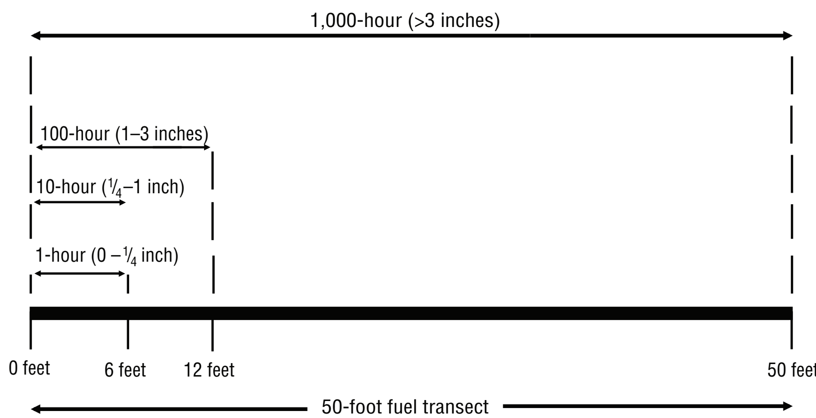


Figure 1—Sampling parameters along each 50-foot transect for the tally of woody fuel components (Stottlemyer 2004).

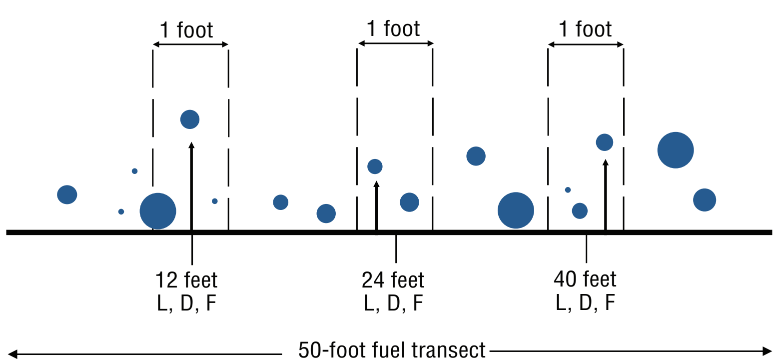


Figure 2—Sampling locations for litter (L) and duff (D) depth and fuel bed height (F) along the 50-foot transects (Stottlemyer 2004). The spheres above represent woody debris of differing diameters intersecting the sampling transects.

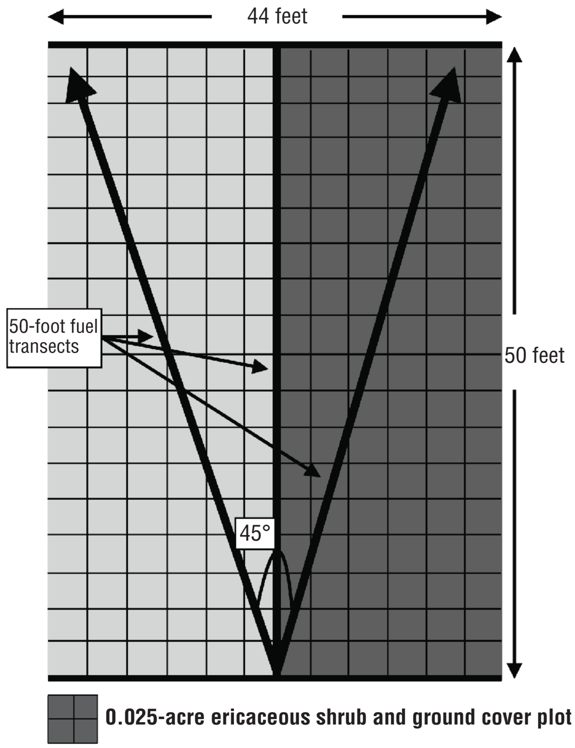


Figure 3—The orientation of ericaceous shrub and ground cover sampling utilized at each plot (Stottlemyer 2004).

**Table 1—Combinations of aspect and elevation used to organize the Southern Appalachian Mountain fuels photo guide**

| Aspect | Elevation |
|---|---|
| *degrees* | *feet* |
| 46–135 | 1,000–1,999 |
| | 2,000–3,499 |
| | ≥3,500 |
| 136–225 | 1,000–1,999 |
| | 2,000–3,499 |
| | ≥3,500 |
| 226–315 | 1,000–1,999 |
| | 2,000–3,499 |
| | ≥3,500 |
| 316–45 | 1,000–1,999 |
| | 2,000–3,499 |
| | ≥3,500 |

center sampling transect. The camera was placed approximately 5 feet above ground when the photographs were taken.

## Development of the Guide

Unlike other guides, we chose to group sites by aspect and elevation instead of forest types or fuel models. Aspect and elevation, alone or in combination, are known to affect forest composition and fuel loading in the study area (McNab 1991, Simon and others 2005). Based upon 12 combinations of aspect and elevation relevant for land managers in the region, 74 photographs were selected for presentation in this guide. In general, the selected photographs were taken in the dormant season. All sites/photographs chosen for the guide are from stands that have had no active management for at least 10 years based on visual indicators and landowner records. Fuel loads represented in these 74 photographs included no logging residues and assumed coarse woody debris inputs from background levels of insects and diseases.

The aspect-elevation combinations are found in table 1. Using these aspect-elevation combinations as a basis for differentiation, specific photographs were then selected to display a fairly wide range of accumulated coarse woody debris ≤3 inches in diameter. If the amount of these materials was similar between locations at a given aspect-elevation combination, ecozone, stand density, and ericaceous shrub cover were evaluated to highlight site variability.

## Using the Guide

This guide contains 74 photographs and accompanying data obtained at each depicted location. These photographs and data are differentiated by combinations of aspect and elevation. Sections of the guide are designated with these combinations in mind, as noted in the table of contents. They are arranged so that when the guide is opened and turned horizontally, the image will be on the top and the information table will be on the bottom (fig. 4).

To utilize the guide, users should select an aspect and elevation combination represented at the larger scale of the area to be managed with prescribed fire. Based on site conditions of an area representative of the fuel conditions of the larger area to be managed with prescribed fire, determine which photograph(s) from the aspect and elevation combination appear most similar to your area. In order to select one image when multiple photographs appear suitable, it may be necessary to narrow the selection based upon differences in ericaceous shrub cover, slope percentage, or 1,000-hour fuels.

While this tool may prove valuable to estimate fuel loading in specific locations of interest within the

| | | | | | | |
|---|---|---|---|---|---|---|
| > Site characteristics > | Ecozone | Low elevation pine | Aspect (degrees) | 96.0 | Elevation (ft.) | 1,538 |
| | Slope (%) | 10.8 | | | PHOTO 2 | |
| > Fuel loads and properties > (tons/acre) | 1-hr. | 0.2 | Litter depth (inches) | 2.0 | NOTES | |
| | 10-hr. | 0.4 | Duff depth (inches) | 1.0 | | |
| | 100-hr. | 2.3 | Fuel height (inches) | 2.5 | | |
| | 1+10+100-hr. | 2.9 | | | | |
| | 1,000-hr. | 7.4 | Ericaceous shrub cover (%) | 3.4 | | |
| | Woody fuels | 10.3 | Vegetation <1 ft. tall (%) | 63.0 | | |

ASPECT: 46–135°/ELEVATION: 1,000–1,999 FEET [15

Figure 4—Photos and data are arranged by aspect and elevation combinations, followed by 1+10+100-hour fuel loads (from least to greatest).

Southern Appalachian region, the limitations of the guide must be considered. These photographs and fuels inventories are based upon specific observations in specific locations generally during the dormant season and will not necessarily be an exact representation of the overall landscape in every situation.

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