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Photo Guides for Appraising Downed Woody Fuels in Montana Forests:
How They Were Made

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ABSTRACT

Eight series of color photographs have been published as three separate photo guides for appraising downed woody fuels in Montana forests. This note tells how these photo guides were constructed. The techniques used to determine the weight and size class distribution of downed woody fuels are given. The procedure used to rate potential fire behavior of the fuel shown in each photo is explained.

KEYWORDS: forest fuels, fuel appraisal

Fuel appraisal (Anderson 1974) is an important fire management task. It is a basic consideration when dispatching initial attack forces for fire suppression and an essential element for planning fuel management activities. Fuel appraisal also provides a basis for developing and evaluating fire management alternatives as part of land management planning.

Forest fuels can be appraised using techniques varying in precision of results and cost of application. Some techniques are suited to application over large areas while others are best applied to small areas. The photo guides described herein are proposed for application at the forest stand level. Precision is unknown but is expected to be intermediate when compared to other fuel appraisal techniques. Precision is probably higher for estimates of fire potential than it is for estimating fuel loads. Cost of application can vary from low to intermediate. This note describes the procedure used to construct the photo guides for appraising downed woody fuels in Montana forests (Fischer 1981a, 1981b, 1981c).

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PHOTO GUIDE CONSTRUCTION

The general procedure as well as many of the techniques used to construct the photo guides are similar to those proposed by the USDA Forest Service (1975) and used by Koski and Fischer (1979) and Maxwell and Ward (1976a, 1976b). There are, however, important differences. The above-cited photo series deal with recently created slash fuels while the photo guides described here deal primarily with fuels resulting from natural processes such as wind, snow, insects, disease, and competition for light and moisture; old logging and thinning slash is also included since it is now a part of the natural fuel complex. Another difference is the method used to predict potential fire behavior. Maxwell and Ward (1976a, 1976b) used the old Rate of Spread-Resistance to Control fuel type rating. Koski and Fischer (1979) used Rothermel's (1972) mathematical model. For the guides described here, experienced judgment of fuel and fire behavior experts is used to evaluate fire behavior potential.

Location of Camera Points

Camera points were located in recently undisturbed forest stands. Large blocks of such stands were sought out and camera points established to reflect the different fuel conditions found in each forest cover type present in the drainage.

Layout of Photo Plots

The area within the field of view of a camera installed at the camera point essentially defined the photo plot. For fuel inventory purposes, three transects were established in the photo plot. These transects had a common beginning at the photo point (fig. 1). The location and length of the transects were determined with the aid of the camera used to photograph the plot. The procedure followed to lay out the plot and its transects was:

1. Set up tripod over the camera point.

2. Mount camera on tripod.

3. Composed desired photo on the camera focusing screen or through the camera viewfinder. Lock camera in this position.

4. Install plot marker (fig. 2) 20 ft (6.10 m) in front of the center of the field of view.

5. Extend a straight line from the camera point, through the plot marker, to farthest point where surface fuels can still be discerned on the camera focusing screen or through the camera viewfinder (fig. 1). Mark this point with a stake.

6. Establish right and left transects by running lines from the camera point to the right and to the left edge of the camera's field of view (fig. 1). Transect length was the same as determined for the center transect. Mark both points with stakes.

While the transect length within a plot was the same, it did vary between plots. Transect length depended on the camera's ability to discern surface fuels. Consequently, transect length will vary with amount of undergrowth and other factors affecting the visibility of the forest floor. Transect length varied between 50 and 100 ft (15.2 and 30.5 m), but more often than not it was about 70 ft (21.3 m).

Figure 1.--Location of transects on photo plot.

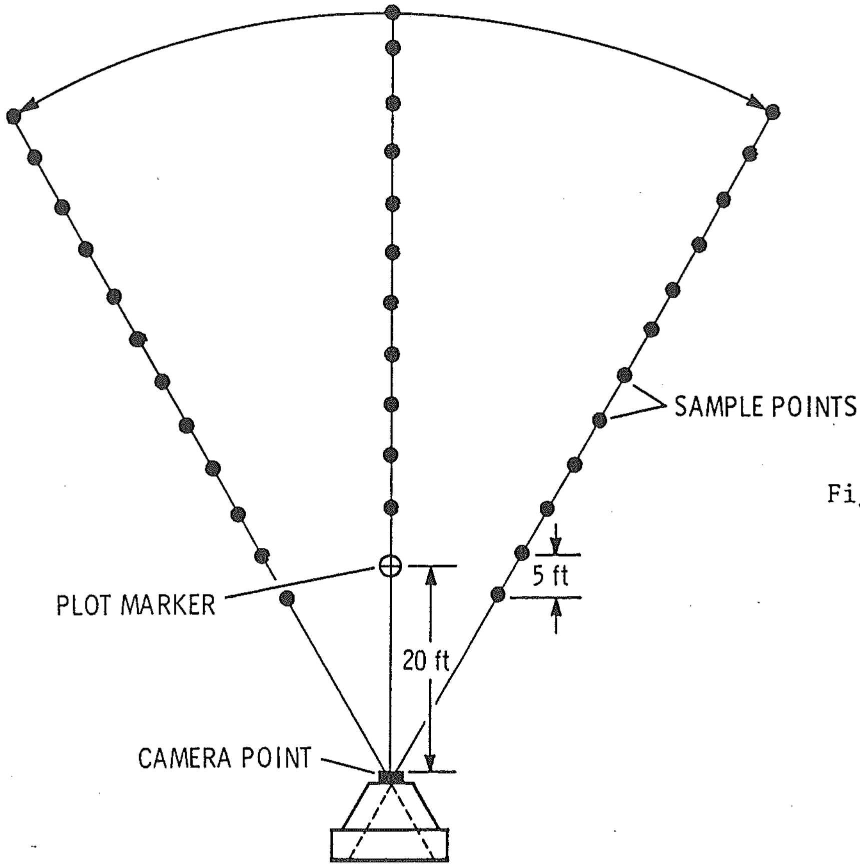

Figure 2.--Location of sampling points on photo plot.

Photographing the Plot

All photography of the plot was done with the camera mounted on a tripod installed over the camera point. Identical photos were taken of each plot using color print film, black and white print film, and color slide film. A Pentax[2] 35 mm camera with a wide-angle (35 mm) lens was used for color slides. Kodak Ektachrome-X film (ASA 64) and High Speed Ektachrome (ASA 160) was used most often for color slides. A Mamiya 6X7 cm shutter-type SLR camera with a 50 mm lens produced the prints. The Mamiya allowed interchanging film holders, which facilitated getting both color and black and white photos with the same camera. About 25 of the plots were photographed using Rolliflex cameras, one loaded with color film and one with black and white film. Both produced satisfactory prints. Color slides also produced satisfactory color prints. Kodak Vericolor II Professional Type S 120 roll film (ASA 100) was used for color prints, and Kodak Tri-X Pan 120 roll film (ASA 400) for black and white prints.

The sequence for photographing the plots was:

1. Set up tripod over the camera point and mount roll film camera on it. (The roll film camera was always used first so the photo could be composed on its focusing screen rather than through the viewfinder of the 35 mm camera.)

2. Compose photograph and lock camera in position.

3. Install plot marker with correct plot number.

4. Lay out plot as indicated in previous section.

5. Take photos using color print film and then black and white print film.

[2]The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an offical endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.

6. Remove camera from tripod and install 35 mm camera in its place.

7. Center camera using plot marker as a guide.

8. Take photo using color slide film.

9. Remove plot marker and take the camera and tripod down.

Plot layout and photography was usually done separately from plot inventory. That is, one crew did the photography and layout while another crew followed behind doing the data collection. Consequently, plot location was recorded on a map and the camera point and transect end point (stakes) were well marked with a flagging tape. The route from the road to the camera point was also well marked with flagging tape.

PLOT INVENTORY

The following information was collected at each plot by the inventory crew:

1. Forest cover type as defined by the Society of American Foresters (1954).

2. Montana forest habitat type as defined by Pfister and others (1977). Pfister's field form was used for this purpose.

3. Age of overstory dominants using an increment borer.

4. Elevation using a barometer.

5. Aspect using a compass.

6. Fuel loading by size class, duff depth, average diameter of fuels 3 inches (7.62 cm) or greater in diameter, percent rotten for 3-inch (7.62-cm) or greater diameter fuels, and volume of sound material 3 inches (7.62 cm) or greater in diameter.

The fuel inventory field procedure developed by Brown (1974) was used to obtain all of the above-mentioned fuel information. Fuel inventory points were installed along each of the three transects established during plot layout (fig. 1). The first point along each transect was installed 20 ft (6.10 m) from the camera point. Additional points were located at 5 ft (1.52 m) intervals along each transect (fig. 2). This design resulted in from 20 to 40 sample points per photo plot. Sampling plane lengths used at each point were as follows:[3]

Fuel size class	Sampling plane length
0-0.25 inch (0-0.64 cm)	4 ft (1.22 m)
0.25-1.00 inch (0.64-2.54 cm)	4 ft (1.22 m)
1.00-3.00 inches (2.54-7.62 cm)	8 ft (2.44 m)
3.00 inches or greater (7.62 cm or greater)	20 ft (6.10 m)

Sampling plane direction was random but kept within the photo plot. That is, sampling plane direction at points along the right and left transects was always kept to the left and right of these lines respectively. This, and locating the first point on each transect 20 ft (6.10 m) from the camera point, insured that the fuel inventory reflected only what was seen by the camera.

[3]Personal communication, James K. Brown, Northern Forest Fire Laboratory, Missoula, Mont.

The downed fuel inventory field sheet developed by Brown (1974) was used to record fuel data collected on each plot (fig. 3).

DOWNED FUEL INVENTORY

FOREST		SUBCOMPARTMENT		ASPECT	
BLOCK		STAND		COVER TYPE	
COMPARTMENT		ELEVATION		HABITAT TYPE	

SIZE CLASS (In.) :	0 - 1	1 - 3	3+
LENGTH OF SAMPLING PLANE (Ft.):			

		NO. OF INTERSECTS			DUFF DEPTH		3+ DIAMETER						FUEL DEPTH		
PLOT NUMBER	SLOPE	0 - .25"	.25 - 1"	1 - 3"	FIRST	SECOND	SOUND	SOUND	SOUND	ROTTEN	ROTTEN	ROTTEN	FIRST	SECOND	THIRD

GROUND FUEL COMPOSITION   If heavy slash, code 1 :

Species	Percent
1.	
2.	
3.	

Figure 3.--Downed fuel inventory field sheet.

Fire Potential Rating

Each plot was rated in terms of its potential fire behavior for an "average bad" fire weather situation. The assumed fire weather situation was: temperature - 85° to 90° F (29° to 32° C), relative humidity - 15 to 20 percent, windspeed - 10 to 15 mi/h (17 to 26 km/h), and last measurable rain - 4 weeks ago.

Five elements of fire behavior were rated: rate of spread, intensity, torching, crowning, and resistance to control. In addition, an overall fire potential rating was assigned to each plot. The rating was subjective. Managers and researcher with experience in prescribed fire and fire control assigned adjective ratings according to the following definitions:

Rate of Spread

Nil--fire cannot sustain itself.

Low--spread will be slow and discontinuous.

Medium--uniform spread possible but can be stopped by aggressive ground attack with hand tools.

High--spread will be rapid; indirect attack on fire front may be required for control.

Extreme--spread will be explosive; little chance of control until weather changes.

Intensity

Nil--fire cannot sustain itself.

Low--cool fire; very little hot spotting required for control.

Medium--fire will burn hot in places; aggressive hot spotting with hand tools likely to be successful.

High--too hot for sustained direct attack with hand tools; aerial tankers or large ground tanker required to cool fire front.

Extreme--direct ground attack not possible; air or ground tanker attack likely to be ineffective.

Torching

Nil--no chance of torching.

Low--occasional tree may torch-out.

Medium--pole-sized understory trees likely to torch-out.

High--most of understory and occasional overstory trees likely to torch-out.

Extreme--entire stand likely to torch-out.

Crowning

Nil--sustained spread in crowns will not occur.

Low--sustained spread in crowns unlikely.

Medium--some crowning likely but will not be continuous.

High--sustained crowning likely.

Extreme--sustained crowning will occur.

Resistance to Control Action

Nil--no physical impediments to line building and holding.

Low--occasional tough spots but not enough to cause serious line building and holding problems.

Medium--hand line construction will be difficult and slow but dozers can operate without serious problems.

High--slow work for dozers, very difficult for hand crews; hand line holding will be difficult.

Extreme--neither dozers nor hand crews can effectively build and hold line.

Overall Fire Potential

Nil--fire will not sustain itself.

Low--fire can be easily controlled by several smokechasers with hand tools.

Medium--aggressive crew-sized (6-10) persons initial attack required for successful control.

High--aggressive crew-sized (25 persons) initial attack with substantial reinforcement required for successful control; 10 percent chance that control action will fail.

Extreme--90 percent chance that control action will fail.

Mathematical models designed to predict fire spread and intensity were not used to evaluate fire potential. Existing mathematical models assume uniform and continuous fuels. Such conditions are the exception rather than the rule in recently undisturbed forest stands in Montana.

All fire potential ratings were done in the field at the photo plot. Most plots were rated by three to five people. A few plots were rated by only two people and some by as many as six. A total of 27 different raters participated. Ratings were, however, done individually without consultation among the raters. The field sheet used by the raters is shown in figure 4.

The fire potential rating method used in developing the photo guides is not without precedent in the Northern Rocky Mountains. It is in many ways a refinement of the time-tested concept of fuel rating introduced more than 40 years ago by L. G. Hornby (1936).

Data Analysis and Summary

Fuel inventory data were analyzed and summarized using the computer program DFINV.[4] Fire potential ratings assigned to each plot by the different raters were averaged to obtain a single set of ratings for the plot. This was done by assigning the following values to each objective rating:

Nil - 1

Low - 2

Medium - 3

High - 4

Extreme - 5

If the average value was halfway between two ratings, it was rounded up or down depending on remarks entered by raters on the field sheet (fig. 4).

[4]Johnston, Cameron M., July 1975. Downed woody material inventory computer program write-up. On file at Northern Forest Fire Laboratory, Missoula, Mont. Program is located at the USDA Computer Center, Fort Collins, Colo., and is available to all who have access to this facility.

FIRE POTENTIAL EVALUATION STUDY RATING SHEET

STAND NO. ____________

DATE ________________

RATER ________________

INSTRUCTIONS: Circle Appropriate Rating and Give Your Reason(s)

1. RATE OF SPREAD: Nil Low Medium High Extreme
   WHY? ____

2. INTENSITY: Nil Low Medium High Extreme
   WHY? ____

3. TORCHING: Nil Low Medium High Extreme
   WHY? ____

4. CROWNING: Nil Low Medium High Extreme
   WHY? ____

5. RESISTANCE TO CONTROL ACTION (Physical - Not Intensity):
   Nil Low Medium High Extreme
   WHY? ____

6. OVERALL HAZARD: Nil Low Medium High Extreme
   COMMENTS: ____

Figure 4.--Field sheet for rating fire potential.

National fire danger rating system fuel models were assigned by evaluating the photograph in terms of the fuel model descriptions provided by Deeming and others (1977). Similarly, stylized fuel models were assigned according to the fuel model descriptions provided by Albini (1976). Fire ecology group assignment was based on the grouping of Montana habitat types (Pfister and others 1977) developed by Davis and others (1980).

Plot data and information were summarized on a data sheet (fig. 5) that accompanies each photo in the guides. Fuel loadings are recorded to the nearest 0.1 ton/acre for all size classes. Actually, reasonable significant figures for loading are:

-- the nearest 0.1 ton/acre for loading less than 10 tons/acre,

-- the nearest 1.0 ton/acre for loadings between 10 and 50 tons/acre, and

-- the nearest 5.0 tons/acre for loadings greater than 50 tons/acre.

DATA SHEET

Stand No. 35A

FOREST COVER TYPE: SAF NO. 218, Lodgepole pine

MONTANA HABITAT TYPE: NO. 720, Subalpine fir/blue huckleberry (ABLA/VAGL)

DOWN & DEAD WOODY FUEL LOADINGS

Size Class (Inches)	Weight T/ac	Weight Kg/m^2
0-0.25	0.3	0.07
0.25-1	1.2	0.27
1-3	5.1	1.14
Subtotal 0-3	6.6	1.48
3-6	4.3	0.96
6-10	1.1	0.25
10-20	0	0
20+	0	0
Subtotal 3+	5.4	1.21
Total	12.0	2.69

NFDRS FUEL MODEL	STYLIZED FUEL MOD. Albini (1976)
H/G	**8/10**

OTHER FUEL DATA

average duff depth; 2.4 in
6.10 *cm*

average diameter, 3+fuels
3.8 in
9.65 *cm*

Percent rotten, 3+fuels: 16 %

Volume of sound 3+fuels:
360 ft^3/ac
25.2 m^3/ha

STAND AND SITE DATA

AGE of overstory dominants:
PICO 123 yrs.

Average slope: 11 %

Aspect: Northwest

Elevation: 6090 ft 1856 *m*

Fire Ecology Group: seven

Remarks:

ESTIMATED FIRE POTENTIAL

Based on an average bad day:
85-90° temp., 15-20% R.H., 10-15 mi/h wind, 4 week since rain.

Rate of spread	Medium
Intensity	Low
Torching	Low
Crowning	Low
Resistance to control	Low
Over all Fire Potential	Low

STAND LOCATION

National Forest: Lewis and Clark

Ranger District: White Sulphur Springs

Drainage: Fourmile Creek

Photo taken: 8/10/78

By: W. C. Fischer

Figure 5.--Plot photo and accompanying data sheet.

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