

TECHNICAL NOTES

A Technique for Measuring Rate of Fire Spread

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Highlight: An inexpensive technique is presented for photographically recording rate of spread of prescribed fires. This technique involves the use of infrared film and a split-field close-up lens. The infrared film enables the fire front to be photographed without interference from visible smoke. The split-field close-up lens provides for inclusion of a timing device in the lower part of the photograph.

Interest in prescribed burning research in rangeland ecosystems has increased dramatically in the past decade. This change in attitude has been caused by two factors: (1) the acceptance that fire has a natural place in most rangeland ecosystems and (2) other vegetation manipulation techniques may be restricted due to environmental impacts.

No longer is it adequate to characterize a prescribed fire as a spring burn, fall burn, hot fire, or a cool fire. If the ecological effects of prescribed burning are to be better understood, more concise data must be recorded. Currently, these data include such factors as wind speed, humidity, air temperature, soil moisture, fuel moisture, fuel loading, fuel bed characteristics, and fire temperature. Other fire characteristics that may prove valuable in ecological research are rate of fire spread, flame length, and fire intensity. Fire intensity, or the rate of energy release, is basically a function of rate of fire spread as modified by fuel characteristics (Bryam 1959). If rate of fire spread and fire intensity are to be used in ecological studies, a need exists for

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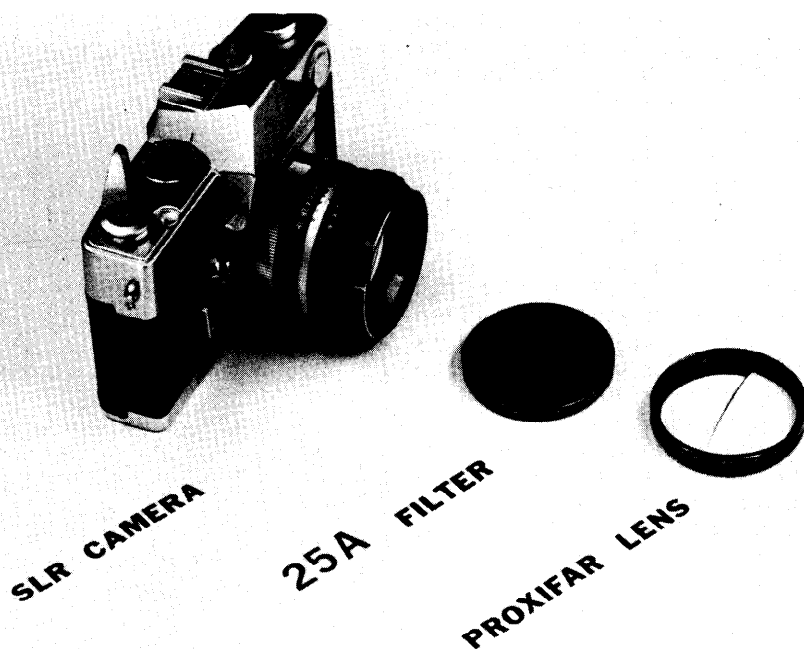


Fig. 1. Camera set up with 25A filter and split-field close-up lens (Proxifar).

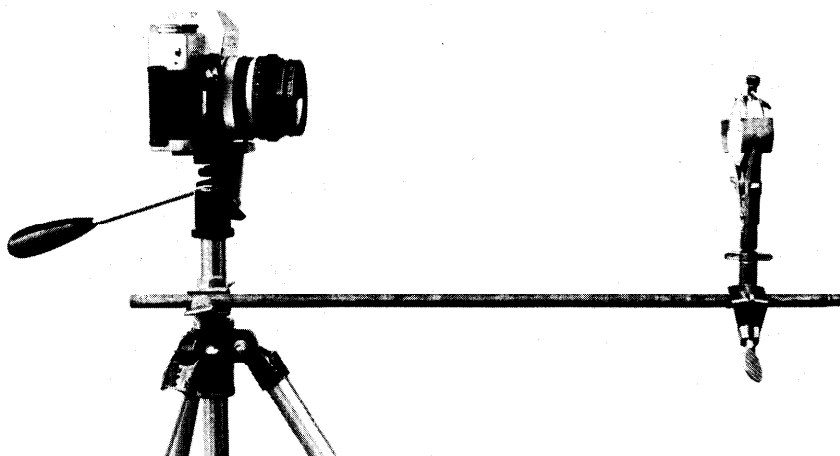


Fig. 2. Camera with stop watch positioned at the focusing length (25 cm) of the Proxifar 10 split-field close-up lens with laboratory clamps.

Table 1. Parameters influencing fire behavior and fire characteristics measured in eastern Oregon.

Burn	Humidity (%)	Air temperature (°C)	Wind speed (km/hr)	Fuel load (kg/ha)	Fuel moisture (%)	Fire temperature ¹ (°C)	Flame length (m)	Rate of fire spread (m/min)	Fire intensity (kcal/m/sec)
1	18	26	10	11,082	77	457	6.7	5.4	499
2	13	23	9	8,239	57	441	6.0	19.4	1,331

¹ Mean of 20 templaq cards per burn.

an inexpensive, efficient, and accurate technique of measurement.

Photographic Techniques

A simple and accurate technique of photographically recording rate of fire spread data is proposed. This technique uses black and white infrared film because it is insensitive to and does not record the smoke image. Therefore, the problem of seeing through dense smoke to determine the location of the fire front is eliminated. With a mounted camera loaded with infrared film and a method of recording the time required for a fire front to move a known ground distance, the rate of fire spread can be accurately calculated.

The most efficient camera for use with black and white infrared film is the 35 mm single lens reflex type (SLR). Kodak High Speed Infrared Film¹ is usually available. The basic camera set up requires a filter and split-field close-up lens (Fig. 1). The 25A or similar dark red filter should be used with infrared film to absorb blue and violet wavelengths. A Proxifar 10¹ or similar split-field close-up lens enables half the negative area to be focused at infinity and the other half to be focused at 25 cm. Therefore, half the picture area will be focused on the fire front, with the other half focused on a timing device. A stop watch, secured to a tripod with laboratory clamps (Fig. 2), can be used.

Black and white infrared film differs from regular panchromatic film because it: (1) must be handled in total darkness, (2) has no designated film speed or ASA number, and (3) does not focus in the same plane as other films. Care must be taken to open the film can, load, and unload the camera in total darkness. This can be accomplished in the field by using a light-proof changing bag. Proper exposure for sharp images will be obtained through trial and error in different situations. An exposure of 1/125 sec at f16 will normally yield acceptable negatives on a clear day. Since infrared film does not focus in the same plane as regular film, an average correction of 0.25% of the focal length should be added to the lens-film extension for infinity focus (Eastman Kodak 1972). Most cameras have an auxiliary focusing mark on the lens for use with infrared film. Infrared film can be processed commercially or in a modestly equipped darkroom.

Field Validation

This technique was tested during two experimental burns with *Artemisia cana* providing the fuel. Photographs were made simultaneously using black and white panchromatic and infrared films (Fig. 3). Three, 2 m tall steel posts were placed 15 m apart in the area to be burned. Rectangular (30 × 45 cm) pieces of sheet metal were attached to the top of each post to facilitate locating them on the photographs. Cameras were located perpendicu-

lar to the post line. In the lower left corner of the infrared photograph, a stop watch was positioned to record time. The photograph taken with panchromatic film shows the interference of smoke. With the infrared film, smoke is not visible and the fire front and flame length can be clearly seen. Thus, when the distance scale of the photograph is adjusted, rate of fire spread and flame characteristics can be calculated from a series of photographs.

During the experimental burns, 8 infrared photographs were taken per burn. Data



Fig. 3. Photographs taken simultaneously with panchromatic (top) and infrared (bottom) black and white films. Stop watch in the infrared photograph was used to record time in a series of photographs.

¹ Mention of product names in this paper does not constitute a recommendation by the Oregon Agr. Exp. Sta., or U.S. Dep. Agr.

from these photographs indicated that there was nearly a four-fold difference in rate of fire spread, although most influencing parameters were similar (Table 1). The most apparent difference was in fuel moisture, which was related to the physiological status of the plants and not to immediate atmospheric conditions. This

illustrates the usefulness of rate of fire spread data, as these two burns would have been considered similar by commonly used criteria.

Total cost of the split-field close-up lens, A25 filter, and changing bag was approximately \$22. Other equipment needed includes camera, tripod, laboratory clamps,

and stop watch. These items are generally available.

Literature Cited

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